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**ABSTRACT:** The goal of our project is to provide key information regarding the nature of the linkage between wintering and breeding habitats for the federally endangered Kirtland's Warbler (*Dendroica kirtlandii*), which breeds almost entirely within Michigan, and winters in The Bahamas. With our team of volunteers, we searched Michigan jack pine stands for Kirtland's Warblers banded on The Bahamas during May-June 2005, and located eight of these males (a total of 848 males and 104 females were observed closely enough to check for bands). Five of the banded birds located this year were newly located in 2005, and three were birds that had also been found in Michigan in 2004, the first year of our study. The other six banded males located in 2004 were not re-sighted in 2005 in repeated visits to their 2004 territories, and are presumed to have died or (less likely) to have dispersed to new territories in areas that we did not search. With the cooperation of our team members in The Bahamas, for one of the three birds first located in 2004 we were able to document a maximum duration of migration from The Bahamas of 36 days. In addition, we located three birds originally banded in Michigan, and documented that two of these birds are now 10 and 11 years old. The previous longevity record for Kirtland's warblers was 9 years, and 11 years ties the record for North American warbler species. The specific purpose of our work is to evaluate the degree to which birds banded within four locations on Eleuthera (The Bahamas), wintering areas are spatially associated on the Michigan breeding territories and to determine duration of migration from The Bahamas to Michigan. Thus far the birds appear to widely distributed across the Michigan breeding grounds (not clumped); these analyses are ongoing. One Kirtland's Warbler took no longer than 36 days to migrate from Eleuthera to Michigan.

## INTRODUCTION

One of the major constraints to developing comprehensive conservation programs for migratory birds is the lack of knowledge linking breeding, stopover and wintering areas. Use of stable isotope chemistry, satellite telemetry, and genetic analyses are providing initial and important suggestions for broad-scale linkages (Webster et al. 2002) but there is often insufficient resolution for conservation programs to apply this information at a site or landscape scale. Thus, data on individually marked birds can be helpful for the fine scale spatial resolution frequently needed to make conservation decisions.

Development of a comprehensive conservation program to protect the endangered Kirtland's Warbler (*Dendroica kirtlandii*) requires protecting breeding and wintering grounds and migratory stopover sites. The results presented here are part of a comprehensive program to protect the endangered Kirtland's Warbler on

its breeding and wintering ground, including The Kirtland's Warbler Research and Training Program which has initiated studies of habitat requirements of over wintering Kirtland's Warblers in The Bahamas.

A key step toward development of a comprehensive program involves evaluating the degree of linkage between specific breeding and wintering areas of Kirtland's Warblers. The immediate purpose of this work is to determine if birds banded on the Eleuthera, The Bahamas wintering areas are also associated with each other on the Michigan breeding grounds. Thus, the focus of this work was to search occupied areas throughout the breeding range to locate as many of these banded birds as possible to further this objective. Ultimately, we expect these data will also help us to better evaluate Kirtland's Warblers survival, correlate arrival dates of Kirtland's Warblers with condition of Kirtland's Warblers immediately prior to spring migration, and to document duration of migration for individual birds. In addition, future surveys to locate banded birds could provide a second estimate of the number of singing males present in occupied stands for comparison to the estimates derived from established line transect count methods.

By documenting both the wintering and breeding territory locations of banded Kirtland's warblers, we hope to add key pieces of information to what is known about this endangered species, such as duration of migration, and timing of mortality. Although sample sizes are small, this information can only be obtained in this manner, and these data would contribute to both our understanding of this species of great management concern in Michigan, as well as to the understanding of songbird life histories in general.

## OBJECTIVES

1. To locate Kirtland's Warblers (*Dendroica kirtlandii*) banded in The Bahamas on breeding colonies in Michigan to observe the extent to which birds banded within the same wintering sites are also spatially associated during the breeding season. Locations of birds to be determined with Global Positioning Systems (GPS) units in both The Bahamas and Michigan, and to be mapped to determine the degree of association.
2. To assess the point within the yearly cycle when mortality of Kirtland's Warblers occurs by noting when color-banded Kirtland's Warblers were last seen; in Michigan or The Bahamas.
3. To document duration of spring 2005 migration for those individual Kirtland's Warblers where both departure date from The Bahamas and arrival date in Michigan can be determined.

## METHODS

Kirtland's Warbler sites in the Lower Peninsula were searched for birds which had been banded in The Bahamas. Guidelines, specified by Federal Endangered Species Permit PRT-697830 (subpermit 04-09) and reviewed by members of the Kirtland's Warbler Recovery Team and others, were provided to a team of observers to ensure that surveys were a minimal source of disturbance to Kirtland's Warblers. These guidelines included instructions that no playback was to be used to attract birds, observers were to retreat from birds that appeared to be agitated by the presence of observers, and to travel through sites using a route least likely to disturb Kirtland's Warblers (e.g. avoid edges of openings). We checked each site, or part of a site, only once. We only deviated from this approach when checking arrival dates of banded birds that had been located in 2004, as multiple visits to a site were needed until either the individual arrived or we concluded that the bird did not arrive (i.e., if the bird was still not present in late May, when populations seemed to have reached typical breeding season densities). Checking of sites was coordinated by D. Ewert and K. Hall with observers instructed to report back as soon as they had completed a survey of an area.

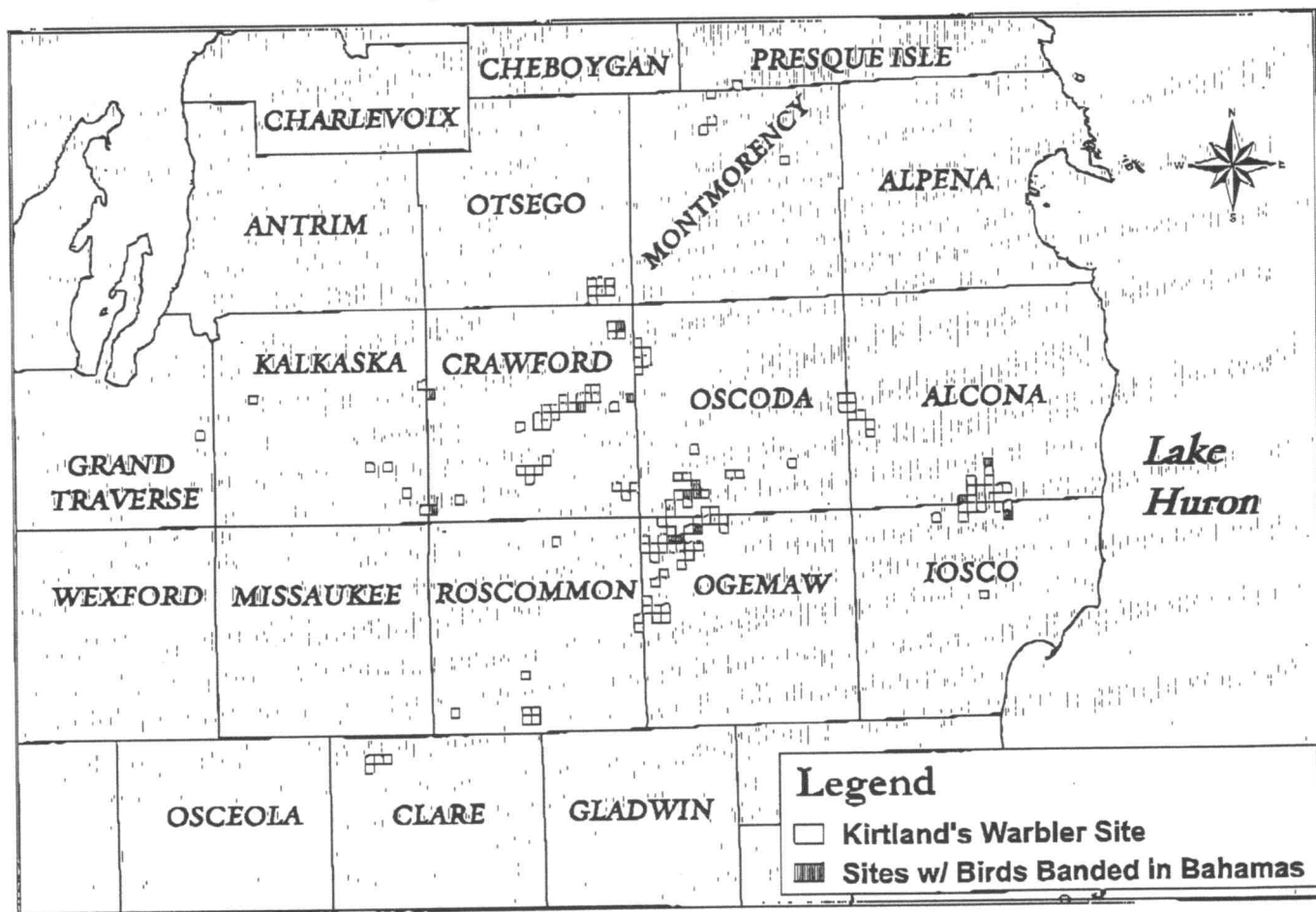
Sites were surveyed from 9 May through 4 July 2005, with most surveys completed in late May/early June. Observers were assigned to particular sites or groups of sites. We focused on the sites with the most birds recorded in the 2004 official survey to increase efficiency in locating birds. Observers were supplied with detailed maps at the scale of a block (1 mile by 1 mile) that showed estimated bird locations from the 2004 census, as well as topographic and forest cover information, to aid them in surveying focal areas. Observers walked slowly through the sites, following roads and residual two-tracks whenever possible, checking for bands on each bird. Most surveys were conducted during the morning (0630-1100), when singing was most active (singing declined rapidly after 1000). A few surveys were completed in the afternoon or early evening. The location of most unbanded birds, and of all banded birds were mapped on topographic maps and recorded with GPS units. Sites were not visited more than twice and birds were typically not followed for more than 30 minutes and only rarely for up to one hour; many males sang in relatively open locations allowing a quick check of the legs once the observer was within range for viewing. There was little evidence that birds responded to the observers; males typically sang and foraged and females were rarely seen, except during early censuses when females were often seen foraging or carrying material for building nests. When birds did appear to react to the presence of an observer, the observer ceased attempting to watch the bird and moved to another bird.

## RESULTS

A total of 952 Kirtland's Warblers (848 males, 104 females) were observed sufficiently well to determine their banding status; eleven of the 848 males (approximately 1%) were banded (Table 1). This work was completed in 286 hours in the field, most of which was done on a volunteer basis. In addition, Steve Sjogren and associates checked 18 males observed in the UP, but none of these were banded. Eight of the 11 banded birds we found had been color-banded in The Bahamas (Table 1), and three had been banded in Michigan. Using the official Kirtland's warbler count of 1418 as an estimate of the total number of singing males, approximately 61% of males found by the census were checked for bands. One additional bird with a single aluminum band was located by an observer on the official census, but the bird could not be relocated and identified. The eight banded males found this year represent approximately 15 % of all the male Kirtland's Warblers banded in The Bahamas from March 2002-April 2005. However, many of the total number of birds banded in The Bahamas are likely to have died prior to this breeding season, so we probably detected a much higher proportion of the total number of banded males present in Michigan. When combined with other banded males located only in prior years (1 in 2003, 5 in 2004), we have identified a breeding territory for 26% of the Bahamas-banded males, and these territories have been scattered among the townships within the species' breeding range (Figure 1). Interestingly, all five of the newly located males were banded in the 2004-2005 Bahamas field season, leading to a 36% detection rate for this subgroup of birds newly banded and known to be alive in the winter directly before this season of our study. We were not able to locate any of the 25 female Kirtland's warblers that were banded in The Bahamas over the same time period (March 2002-April 2005). For one of the Bahamas-banded birds, we were able to work with our collaborators on The Bahamas to estimate a maximum duration of migration of 36 days; this bird was first confirmed in Michigan on May 20, but was likely present on May 19 as well.

**Table 1. Summary of birds observed by sex and banding status, organized by township within various Kirtland's warbler management units. The effort column indicates total time spent looking for birds by the observers listed in the last column; there is no column for banded females because none were found. Banded birds that were originally banded in Michigan, not The Bahamas, are shown in parenthesis in the banded male column.**

County	Township	Unit Name	Band. males	Unband. males	Unband. females	Effort (min)	Observer(s)
Alcona	26N05E	McKinley KWMA	0	32	2	565	D. Ewert, K. Philippe
Oscoda	26N04E	McKinley KWMA	0	6	1	55	D. Ewert
Oscoda	27N04E	McKinley KWMA	0	0	0	10	D. Ewert
Alcona	25N07E	Pine River	1	86	9	910	P. Thompson, J. Stevens, J. Baumgartner, KW Census
Iosco	24N06E	Pine River	0	11	0	30	J. Stevens, KW Ccensus
Iosco	24N07E	Pine River	0	48	0	1370	G. Falkenhagen, J. Stevens
Clare	20N05W	Leota	0	11	3	250	P. Doran
Clare	20N06W	Leota	0	19	1	410	D. Ewert, M. Hamas, K. Hall
Crawford	25N01W	El Dorado	0	26	0	560	D. Ewert, K. P
Crawford	25N04W	Fletcher	1	5	1	180	R. Perez, K.Hall, D. Ewert
Crawford	28N01W	Lovells KWMA	1	30	3	830	D. Ewert, D. Mehlman, K. Philippe., K. Hall
Crawford	27N04W	Manistee R. KWMA	0	1	0	60	R. Perez
Crawford	26N02W	Stephan Br. etc.	0	15	0	360	R. Percz, K. Hall
Crawford	27N01W	Stephan Br. etc.	0	16	2	320	K. Philippe, D. Ewert
Crawford	27N02W	Stephan Br. etc.	1	11	3	660	R. Perez, B. Hess, K.Hall
Kalkaska	25N05W	West Camp	0	3	0	180	R. Perez
Montmor.	31N02E	Clear Lk, etc.	0	6	0	215	K. Hall
Ogemaw	24N01E	Damon	4	246	53	4538	D. Ewert, K. Hall, K. Philippe, A. Zemke, J. Weinrich
Ogemaw	24N02E	Damon	1	83	11	1555	J. Weinrich, D. Mehlman, K. Philippe., K. Hall, D. Ewert
Ogemaw	23N01E		0	4	0	150	M. Petrucha
Oscoda	25N01E	Big Creek KWMA	0	47	2	957	K. Hall, D. Ewert
Oscoda	25N02E	Big Creek KWMA	2	9	2	590	K. Hall, D. Ewert, J. Weinrich
Oscoda	25N02E	Mack Lake	0	2	0	60	D. Ewert
Oscoda	25N03E	Mack Lake	0	30	5	570	D. Ewert, R. Dzedzic, K. Philippe
Oscoda	27N01E	Skidder/Farrington	0	30	0	510	D. Mehlman, K. Hall
Oscoda	28N01E	Skidder/Farrington	0	31	0	440	D. Ewert, D. Mehlman
Otsego	29N01W	Crapo Lake	0	22	5	520	D. Ewert, K. Philippe, K. Hall
Roscom.	24N02W	DNR Airport	0	2	0	30	J. Weinrich
Roscom.	23N01W	St Helen Motor	0	5	1	290	M. Petrucha
<b>TOTAL</b>			<b>11</b>	<b>837</b>	<b>104</b>	<b>17175 (286.25 hours)</b>	



**Figure 1. Cumulative distribution (by-section) of Kirtland's Warblers banded on Eleuthera, The Bahamas, relative to the current range of Kirtland's Warblers on their Michigan breeding grounds. It should be noted that the highest densities of the warblers are currently found in north-west Ogemaw county and southwest Oscoda, where seven of the banded birds have been found.**

The three Michigan banded birds were originally banded in 1995, 1996, and 1997, and based on the band date and age at banding (adult or nestling), these birds were 8, 10, and 11 years old in 2005.

In addition, for many of the blocks we surveyed, we have detailed GPS-referenced locations for all Kirtland's Warblers observed, and felt confident that we had seen most, if not all, birds present. These spatial data files represent a useful resource for comparison with the 2005 official census data, and we will work with members of the Kirtland's warbler recovery team to identify the most fruitful way to conduct these comparisons.

## DISCUSSION

It is important, and exceedingly difficult, to document both breeding and wintering locations of individual birds. The greatest opportunities for such documentation are for species, or populations of species, with highly restricted breeding and wintering ranges and that are intensively surveyed. As such a species, the

Kirtland's Warbler represents an extremely unusual case in which it is logistically feasible to conduct intensive surveys of breeding colonies to search for birds banded on the less-well known winter habitats. Our relatively conservative estimates of locating 15% (36% for the subset banded in 2004/2005) of the banded males wintering on Eleuthera, The Bahamas, that were still alive prior to spring migration of 2005 compares favorably with recovery rates achieved through the radio telemetry methods that have been used to link breeding and wintering habitats for larger species which concentrate in particular habitats, such as shorebirds (e.g., 24% of 132 Western Sandpipers (*Calidris mauri*); Bishop and Warnock, 25% of 40 Pacific Golden Plovers (*Pluvialis fulva*); Johnson et al. 2001). In addition, surveys for color-banded warblers can be done repeatedly (e.g., following every migration period), whereas radio telemetry techniques are typically limited to a number of weeks.

Although exceedingly rare, there have been a few documented cases of individual banded birds being located on both winter and breeding habitats. Sykes (unpubl. data) located one banded male Kirtland's Warbler near Governor's Harbour, Eleuthera during two winters (see Sykes and Clench 1998) that was found for three summers at Bald Hill, Crawford County, Michigan. This is the only previous record of a known individual Kirtland's Warbler found on both the wintering and breeding grounds.

There are few other cases where individual songbirds have been located on both breeding and wintering ranges. One Southwestern Willow Flycatcher (*Empidonax traillii extimus*) banded in Ash Meadows National Wildlife Refuge, Nevada was relocated in Guanacaste province, Costa Rica and another bird banded in Gila County, Arizona was also relocated in Guanacaste, Costa Rica ((Koronkiewicz and Sogge 2002, Mary Whitfield, pers. comm.). The bird banded in Arizona returned to the same Costa Rica site in two consecutive winters. In addition, one color-banded Bicknell's Thrush (*Catharus bicknelli*), a species that like the Kirtland's Warbler has a small population and restricted wintering range, was observed on territory in winter in the Dominican Republic after being banded as a yearling in Vermont (Rimmer and McFarland 2001). Rimmer and McFarland (2001) also noted that even though winter observations of marked shorebirds and some raptors are more common than observations of landbirds, the USGS Bird Banding Lab only had records of 15 individuals found in both winter and summer. Rimmer and McFarland (2001) also cited the observation of a single Ovenbird (*Seiurus aurocapillus*) banded in Pennsylvania and relocated in Belize (Dowell and Robbins 1998), two Least Bell's Vireos (*Vireo bellii pusillus*) banded in southern California and later observed in Baja Mexico (B. Kus, unpublished data), and an Indigo Bunting (*Passerina cyanea*) banded in Michigan and relocated in Campeche, Mexico (D. Dawson, unpublished data).

In most cases where both winter and summer locations of individual passerines are known, it results from chance encounters rather than systematic searches. The ability to systematically search for banded Kirtland's Warblers is thus a major contribution made possible by the intensive winter banding and habitat use work done by the Kirtland's Warbler Research and Training Program.

Although our sample size is very small, these data suggest that Kirtland's Warblers over wintering at the same site (there are several sites for banding in The Bahamas) breed at two or more different sites. In other words, there is no tight linkage between wintering and breeding areas at such a fine spatial scale. This is consistent with the dispersal of birds on the Michigan breeding grounds as individuals have been documented to breed at different sites in different years and nestlings have been located up to 676 km from their natal site (Walkinshaw 1983). This result also is in agreement with stable isotope work on Bicknell's Thrush (Hobson et al. 2001) and Black-throated Blue Warblers (*Dendroica caerulescens*; Chamberlain et al. 1997) that suggest that other migratory songbirds that breed in different regions of species' ranges mix at wintering sites. However, it is possible that there is some level of association (i.e., when compared to random assortment) at larger scales, and these analyses are currently in progress.

An exciting, unexpected result was locating the two very old birds --10 and 11 years old. The previous longevity record for Kirtland's warblers listed at the USGS Breeding Bird Laboratory (the entity that permits

all banding of birds) was nine years (Klimkiewicz 2005). The age of 11 years ties the longest-lived warbler of any species known to the Breeding Bird Lab; we hope to search for these birds again in 2006 to see if the Kirtland's warbler can set a new record.

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This work is an extension of the intensive banding and other efforts of the Kirtland's Warbler Research and Training program on Eleuthera, The Bahamas.

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